H135 Clinicopathologic Correlations in a Free-Dive Competition Fatality

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The goal of this presentation is to introduce the first pathological examination of the effects of pressure-related injury on the lungs during competitive free-diving and the disastrous consequences of repetitive lung squeeze.

This presentation will impact the forensic science community by demonstrating for the first time the pathological changes that may occur when a competitive free-diver repetitively exposes his lungs to injury.

This is an important investigation for the free-diving community as this death is the first death of a free-diver in a competitive situation in the history of competitive free-diving. Its implications impact our understanding of the physiological and pathological changes that occur when exposing the lungs to repetitive pressure-related injury. This will impact the forensic science community by introducing the pathological findings seen in such injuries in the event that another death occurs.

Pressure-related lung injury is well known in the diving community with many factors playing a role in susceptibility to such an injury. Known risk factors include: diving too fast to depth, decreased flexibility of the chest wall, and stress. Before this pathological examination, only signs and symptoms seen in divers experiencing a lung squeeze were known. The clinical symptoms include hemoptysis and shortness of breath. The diving community has not known the extent of damage occurring at the tissue level with repetitive lung squeezes and the consequences of this tissue damage to both future diving and in individual health.

A 32-year-old male with no significant past medical history was competing in an international free-diving competition. He was the first American to ever reach 100m on one breath of air and at the time of his death was considered to be in good health. He attempted a 74m dive without fins 48 hours after a previous dive had resulted in hemoptysis immediately after the dive. He developed respiratory distress 30 seconds after surfacing under his own power. His face was not submerged as rescue divers assisted and helped him to a platform where a physician was available to assist him. Despite her efforts, he progressed to respiratory arrest and subsequent death. An initial medicolegal autopsy identified acute lung injury complicating barotrauma. Intra-alveolar hemorrhage was identified with both acute hemorrhage and hemosiderin-laden macrophages that were seen. Additional questions remained in the first-ever reported death in a free-diving competition. Better understanding of the pathologic changes occurring after repetitive injury was sought by the sponsoring agency and the diving community in order to prevent further deaths from this type of injury. The family authorized a second autopsy examination of the viscera preserved at the medicolegal autopsy.

A pathological examination was undertaken as the first direct study of pressure-related lung injury from deep breath-hold diving. Repeated barotrauma causes recurrent pulmonary hemorrhage and acute edema, hemorrhagic edema, and hemosiderin macrophages seen most extensively in the periphery of the lungs and near the conducting airways. The alveolar capillaries were found to be the source of the pulmonary hemorrhage. Thorough examination of the available airways revealed no proximal source of hemorrhage. Mild interstitial fibrosis was seen in the areas with more extensive hemorrhage. Additionally, mild fibrointimal thickening of the pulmonary arteries was identified with right ventricular hypertrophy — markers of pulmonary hypertension. The physiological changes occurring in response to repetitive barotrauma lead to pulmonary alveolar and vascular remodeling, increasing the risks in subsequent dives.

Ultimately, this diver had developed enough physiologic derangement in response to repetitive barotrauma that he had no reserve when placed under the stress of a long and deep dive. The understanding of this process will bring change to the sport of free-diving and a better understanding of the limits of the human body when placed under stress and pressure over time. Understanding the pathologic changes that occur with this type of injury will direct the care of people experiencing similar symptoms and may help them make a more educated decision whether or not to continue diving after such an injury. Knowing the pathologic changes will direct further research to better understand human physiological adaptation and the potential for serious injury.

Pulmonary Barotrauma, Free-Dive Competition, Pathology of Lung Squeeze

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